Calibration Kit Overview

The Agilent 85054D type-N calibration kit is used to calibrate Agilent network analyzers up to 18 GHz for measurements of components with 50Ω type-N connectors.

The standards in this calibration kit allow you to perform simple 1- or 2-port and TRM (thru–reflect–match) calibrations.

This manual describes the 85054D calibration kit and provides replacement part numbers, specifications, and procedures for using, maintaining, and troubleshooting the kit.

Kit Contents

The 85054D calibration kit contains the following:

- offset opens and shorts, and broadband load terminations
- four type-N to 7 mm adapters
- two type-N to type-N adapters
- a 3/4 inch, 135 N-cm (12 in-lb) torque wrench for use on the type-N connectors
- a spanner wrench

Refer to Table 6-1 and Figure 6-1 for a complete list of kit contents and their associated part numbers.

Offset Opens and Shorts

The offset opens and shorts are built from parts that are machined to the current state-of-the-art in precision machining.

The offset short's inner conductors have a one-piece construction, common with the shorting plane. The construction provides for extremely repeatable connections.

The offset opens have inner conductors that are supported by a strong, low-dielectric constant plastic to minimize compensation values.

Both the opens and shorts are constructed so that the pin depth can be controlled very tightly, thereby minimizing phase errors. The lengths of the offsets in the opens and shorts are designed so that the difference in phase of their reflection coefficients is approximately 180 degrees at all frequencies.

Adapters

Like the other devices in the kit, the adapters are built to very tight tolerances to provide good broadband performance. The adapters utilize a dual-beaded connector structure to ensure stable, repeatable connections. The beads are designed to minimize return loss and are separated far enough so that interaction between the beads is minimized.

Calibration Definitions

The calibration kit must be selected and the calibration definitions for the devices in the kit installed in the network analyzer prior to performing a calibration.

The calibration definitions can be:

- resident within the analyzer
- manually entered from the front panel

Class assignments and standard definitions may change as more accurate model and calibration methods are developed. You can download the most recent class assignments and standard definitions from Agilent's Calibration Kit Definitions Web page at www.na.tm.agilent.com/pna/caldefs/stddefs.html.

Refer to your network analyzer user's guide or embedded Help for instructions on manually entering calibration definitions, selecting the calibration kit, and performing a calibration.

NOTE The 8510 network analyzer is no longer being sold or supported by Agilent. However, you can download the 8510 class assignments and standard definitions from Agilent's Calibration Kit Definitions Web page at www.na.tm.agilent.com/pna/caldefs/stddefs.html

Equipment Required but Not Supplied

Connector cleaning supplies and various electrostatic discharge (ESD) protection devices are not supplied with the calibration kit but are required to ensure successful operation of the kit. Refer to Table 6-2 on page 6-3 for ordering information.

Incoming Inspection

Refer to “Kit Contents” on page 1-2 to verify a complete shipment. Use Table 1-1 on page 1-5 to record the serial numbers of all serialized devices in your kit.

Check for damage. The foam-lined storage case provides protection during shipping. If the case or any device appears damaged, or if the shipment is incomplete, refer to “Contacting Agilent” on page 5-5. Agilent will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company. See .“Returning a Kit or Device to Agilent” on page 5-4.

Serial Numbers

A serial number is attached to this calibration kit. The first four digits followed by a letter comprise the serial number prefix; the last five digits are the suffix, unique to each calibration kit.

Recording the Device Serial Numbers

In addition to the kit serial number, the devices in the kit are individually serialized (serial numbers are labeled onto the body of each device). Record these serial numbers in Table 1-1. Recording the serial numbers will prevent confusing the devices in this kit with similar devices from other kits.

Table 1-1 Serial Number Record for the 85054D

Device	Serial Number
Calibration kit	______________________
Broadband load -m-	______________________
Broadband load -f-	______________________
Open -m-	______________________
Open -f-	______________________
Short -m-	______________________
Short -f-	______________________
Adapters	
Type-N -m- to Type-N -m-	______________________
Type-N -f- to Type-N -f-	______________________
Type-N -f- to 7 mm	______________________
Type-N -f- to 7 mm	______________________
Type-N -m- to 7 mm	______________________
Type-N -m- to 7 mm	______________________

Calibration Kits Documented in This Manual

This manual applies to any 85054D calibration kit whose serial number prefix is listed on the title page. If your calibration kit has a different serial number prefix, refer to the "Calibration Kit History" section below for information on how this manual applies.

Calibration Kit History

This section describes calibration kits with serial number prefixes lower that the ones listed on the title page.

85054D Kits with Serial Prefix 2901A

These calibration kits did not have a calibration definitions disk to support the Agilent 8510C network analyzer. The part numbers provided in this manual are the recommended replacement parts for these kits. The devices in these kits should meet the specifications published in this manual.

Precision Slotless Connectors

The female type-N connectors in this calibration kit are metrology-grade, precision slotless connectors (PSC). A characteristic of metrology-grade connectors is direct traceability to national measurement standards through their well-defined mechanical dimensions.

Conventional female center conductors are slotted. When mated, the female center conductor is flared by the male pin. Because physical dimensions determine connector impedance, electrical characteristics of the female connector (and connection pair) are dependent upon the mechanical dimensions of the male pin. While connectors are used in pairs, their male and female halves are always specified separately as part of a standard, instrument, or device under test. Because of these facts, making precision measurements with the conventional slotted connector is very difficult, and establishing a direct traceability path to primary dimensional standards is nearly impossible.

The precision slotless connector was developed to eliminate these problems. All PSCs are female. A PSC incorporates a center conductor with a solid cylindrical shell that defines the outside diameter of the female center pin. Its outside diameter and, therefore, the impedance in its region does not change. The inner part provides an internal contact that flexes to accept the allowed range of male pin diameters.

The calibration of a network analyzer having a conventional slotted female connector on the test port remains valid only when the device under test and all calibration standards have identical male pin diameters. For this reason PSC test port adapters are supplied in most calibration kits.

Precision slotless connectors have the following characteristics:

- There is no loss of traceable calibration on test ports when the male pin diameter of the connector on the device under test is different from the male pin diameter of the calibration standard.
- The female PSC and its mating male connector can be measured and specified separately as part of the device either is attached to.
- All female connectors can have a known, stable impedance based only on the diameters of their inner and outer conductors.
- Female calibration standards can be fully specified. Their specifications and traceability are unaffected by the diameter of the male mating pin.
- A fully traceable performance verification is made using a precision 50 ohm airline having a PSC.
- Measurement repeatability is enhanced due to non-changing connector characteristics with various pin diameters.

With PSCs on test ports and standards, the percentage of accuracy achieved when measuring at 50 dB return loss levels is comparable to using conventional slotted connectors measuring devices having only 30 dB return loss. This represents an accuracy improvement of about 10 times.

Clarifying the Terminology of a Connector Interface

In this document and in the prompts of the PNA calibration wizard, the sex of cable connectors and adapters is referred to in terms of the center conductor. For example, a connector or device designated as 1.85 mm –f– has a 1.85 mm female center conductor.

8510-series, 872x, and 875x ONLY: In contrast, during a measurement calibration, the network analyzer softkey menus label a 1.85 mm calibration device with reference to the sex of the analyzer's test port connector—not the calibration device connector. For example, the label `SHORT(F)` refers to the short that is to be connected to the female test port. This will be a male short from the calibration kit.

Table 1-2 Clarifying the Terminology of Connectors: Examples

Terminology	Meaning
Short –f–	Female short (female center conductor)
Short (f)	Male short (male center conductor) to be connected to female port

A connector gage is referred to in terms of the connector that it measures. For instance, a male connector gage has a female connector on the gage so that it can measure male devices.

Preventive Maintenance

The best techniques for maintaining the integrity of the devices in this kit include:

- routine visual inspection
- cleaning
- proper gaging
- proper connection techniques

All of the above are described in Chapter 3 , "Use, Maintenance, and Care of the Devices." Failure to detect and remove dirt or metallic particles on a mating plane surface can degrade repeatability and accuracy and can damage any connector mated to it. Improper connections, resulting from pin depth values being out of the *observed* limits (see Table 2-2 on page 2-4), or from bad connections, can also damage these devices.

When to Calibrate

A network analyzer calibration remains valid as long as the changes in the systematic error are insignificant. This means that changes to the uncorrected leakages (directivity and isolation), mismatches (source match and load match), and frequency response of the system are small (<10%) relative to accuracy specifications.

Change in the environment (especially temperature) between calibration and measurement is the major cause in calibration accuracy degradation. The major effect is a change in the physical length of external and internal cables. Other important causes are dirty and damaged test port connectors and calibration standards. If the connectors become dirty or damaged, measurement repeatability and accuracy is affected. Fortunately, it is relatively easy to evaluate the general validity of the calibration. To test repeatability, remeasure one of the calibration standards. If you can not obtain repeatable measurements from your calibration standards, maintenance needs to be performed on the test port connectors, cables and calibration standards. Also, maintain at least one sample of the device under test or some known device as your reference device. A verification kit may be used for this purpose. After calibration, measure the reference device and note its responses. Periodically remeasure the device and note any changes in its corrected response which can be attributed to the test system. With experience you will be able to see changes in the reference responses that indicate a need to perform the measurement calibration again.

2 Specifications

Environmental Requirements

Table 2-1 Environmental Requirements

Parameter	Limits
Temperature	
Operating[a]	+20 °C to +26 °C
Storage	–40 °C to +75 °C
Error-corrected range[b]	± 1 °C of measurement calibration temperature
Relative humidity	Type tested, 0% to 95% at 40 °C, non-condensing

a. The temperature range over which the calibration standards maintain conformance to their specifications.
b. The allowable network analyzer ambient temperature drift during measurement calibration and during measurements when the network analyzer error correction is turned on. Also, the range over which the network analyzer maintains its specified performance while correction is turned on.

Temperature—What to Watch Out For

Changes in temperature can affect electrical characteristics. Therefore, the operating temperature is a critical factor in performance. During a measurement calibration, the temperature of the calibration devices must be stable and within the range specified in Table 2-1.

IMPORTANT Avoid unnecessary handling of the devices during calibration because your fingers are a heat source.

Mechanical Characteristics

Mechanical characteristics such as center conductor protrusion and pin depth are *not* performance specifications. They are, however, important supplemental characteristics related to the electrical performance of devices. Agilent Technologies verifies the mechanical characteristics of the devices in this kit with special gaging processes and electrical testing. This ensures that the device connectors do not exhibit any excess center conductor protrusion or improper pin depth when the kit leaves the factory.

"Gaging Connectors" on page 3-6 explains how to use gages to determine if the kit devices have maintained their mechanical integrity. (Refer to Table 2-2 on page 2-4 for typical and observed pin depth limits.)

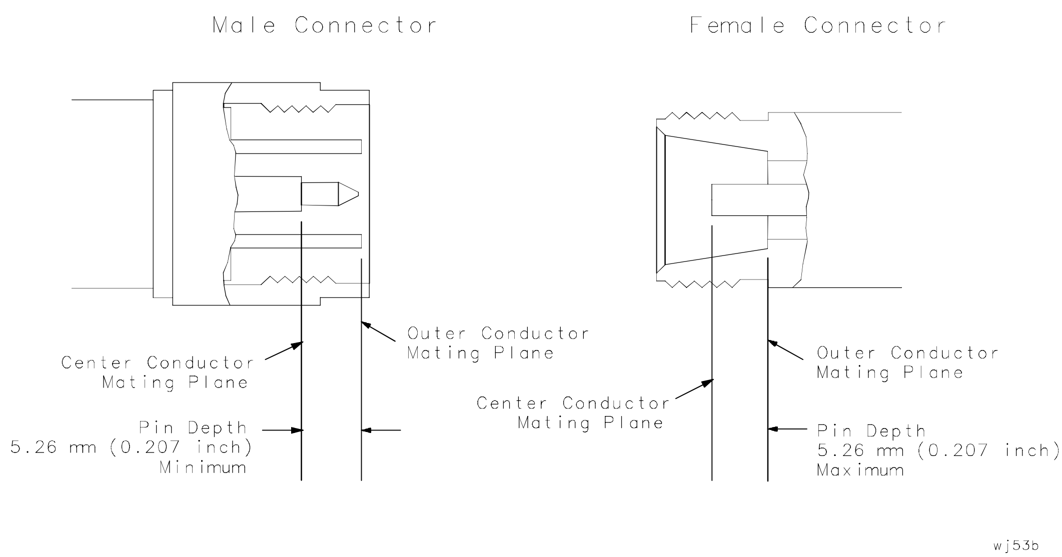
Pin Depth

Pin depth is the distance the center conductor mating plane differs from being flush with the outer conductor mating plane. Refer to Figure 2-1. Some coaxial connectors, such as 2.4 mm and 3.5 mm, are designed to have these planes nearly flush. Type-N connectors, however, are designed with a pin depth offset of approximately 5.26 mm (0.207 inch), not permitting these planes to be flush. The male center conductors are recessed by the offset value while the female center conductors compensate by protruding the same amount. This offset necessitates the redefining of pin depth with regard to protrusion and recession.

Protrusion refers to a male type-N connector center conductor having a pin depth value less than 5.26 mm (0.207 inch), or a female type-N connector center conductor having a pin depth value greater than 5.26 mm (0.207 inch).

Recession refers to a male type-N connector center conductor having a pin depth value greater than 5.26 mm (0.207 in), or a female type-N connector center conductor having a pin depth value less than 5.26 mm (0.207 inch).

Figure 2-1 Connector Pin Depth



NOTE The gages for measuring type-N connectors compensate for the designed offset of 5.26 mm (0.207 inch), therefore, protrusion and recession readings are in relation to a *zero* reference plane (as if the inner and outer conductor planes were intended to be flush). Gage readings can be directly compared with the *observed* values listed in Table 2-2.

The pin depth value of each calibration device in this kit is not specified, but is an important mechanical parameter. The electrical performance of the device depends, to some extent, on its pin depth. The electrical specifications for each device in this kit take into account the effect of pin depth on the device's performance. Table 2-2 lists the typical pin depths and measurement uncertainties, and provides observed pin depth limits for the devices in the kit. If the pin depth of a device does not measure within the *observed* pin depth limits, it may be an indication that the device fails to meet electrical specifications. Refer to Figure 2-1 for an illustration of pin depth in type-N connectors.

Table 2-2 Pin Depth Limits

Device	Typical Pin Depth micrometers (10^{-4} inches)	Measurement Uncertainty[a] micrometers (10^{-4} inches)	Observed Pin Depth Limits[b] micrometers (10^{-4} inches)
Opens	0 to –12.7 (0 to –5.0)	+3.8 to –3.8 (+ 1.5 to –1.5)	+3.8 to –16.5 (+ 1.5 to –6.5)
Shorts	0 to –12.7 (0 to –5.0)	+3.8 to –3.8 (+ 1.5 to –1.5)	+3.8 to –16.5 (+ 1.5 to –6.5)
Broadband loads	0 to –50.8 (0 to –20.0)	+3.8 to –3.8 (+ 1.5 to –1.5)	+3.8 to –54.6 (+ 1.5 to –21.5)
Adapters (7 mm end)	0 to –50.8 (0 to –20.0)	+3.8 to –3.8 (+ 1.5 to –1.5)	+3.8 to –54.6 (+ 1.5 to –21.5)
Adapters (type-N end)	0 to –12.7 (0 to –5.0)	+3.8 to –3.8 (+ 1.5 to –1.5)	+3.8 to –16.5 (+ 1.5 to –6.5)

a. Approximately +2 sigma to –2 sigma of gage uncertainty based on studies done at the factory according to recommended procedures.
b. Observed pin depth limits are the range of observation limits seen on the gage reading due to measurement uncertainty. The depth could still be within specifications.

NOTE When measuring pin depth, the measured value (resultant average of three or more measurements) is *not* the true value. Always compare the measured value with the observed pin depth limits in Table 2-2 to evaluate the condition of device connectors.

Electrical Specifications

The electrical specifications in Table 2-3 apply to the devices in your calibration kit when connected with an Agilent precision interface.

Table 2-3 Electrical Specifications

Device	Frequency (GHz)	Parameter	Specification
Broadband loads	DC to ≤ 2 > 2 to ≤ 8 > 8 to ≤ 18	Return Loss Return Loss Return Loss	≥ 40 dB (≤0.01000ρ) ≥ 36 dB (≤0.01585ρ) ≥ 34 dB (≤0.01995ρ)
Adapters (both styles)	DC to ≤ 8 > 8 to ≤ 18	Return Loss Return Loss	≥ 34 dB (≤ 0.0200ρ) ≥ 28 dB (≤0.0398ρ)
Offset Opens[a]	at 18	Deviation from Nominal Phase	±1.5°
Offset Shorts[a]	at 18	Deviation from Nominal Phase	±1.0°

a. The specifications for the opens and shorts are given as allowed deviation from the nominal model as defined in the standard definitions (see "Class Assignments and Standard Definitions Values are Available on the Web" on page A-2).

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST) to the extent allowed by the institute's calibration facility, and to the calibration facilities of other International Standards Organization members. See "How Agilent Verifies the Devices in This Kit" on page 4-2 for more information.